



Type AHF

Active Harmonic Filter

User's Manual

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PREFACE

We thank you for the trust in selecting the **ARTECHE** Type AHF Active Harmonic Filter.

This equipment complies with UL 508 and is authorized to use the UL marking.



The purpose of this user's manual is to describe the operating principles for the **ARTECHE** Active Harmonic Filter and providing users with necessary procedures for the installation and operation of the system.

SAFETY

 CAUTION!	System installation, operation and maintenance should only be carried out by authorized and trained personnel, adhering to local AND international regulations.
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 DANGER	Before any maintenance to the <i>ARTECHE</i> AHF, make sure the power switch is off, and wait at least for THREE minutes to ensure any residue current has been completely discharged from the DC Capacitor Module.
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The following precautions should be observed at all times during the installation, operation, maintenance or calibration of the AHF:

1. Ensure the AHF has been properly grounded before the switch is turned on. Bad grounding will cause malfunction or possible electrical shock.
2. Maintenance should be conducted with care to avoid possible electrical shock. It is strongly advised that voltage levels of circuits are checked, and all stored-energy components have been fully discharged before maintenance is executed. Safety goggles should be worn throughout the maintenance process.
3. If the AHF has been incorrectly installed, harmonic current and voltage may be applied onto the power system resulting in damage to the equipment and other systems.
4. Incorrect operating methods may cause damage to equipment components and degrade the system's performance.
5. An improper *switch-off* procedure of the AHF may cause damage to the equipment.
6. Replacement of any components or parts should be done by an authorized technician.

FUNCTIONS AND OPERATING PRINCIPLES

FUNCTIONS

The AHF is a solid-state power converter that provides the following advantages:

- Eliminates harmonic currents from non-linear loads.
- Compensates reactive power factor of lagging loads.
- Acts as a virtual damping resistor to prevent possible harmonic resonance.

The AHF performs like an inverse harmonic current generator. The AHF will measure the harmonics generated from the non-linear loads and cancel these harmonics with a newly generated opposite phase shifted harmonic current of the same amplitude. By canceling the harmonic currents in the circuit, there will be

1. No risk of harmonic resonance.
2. Significant reduction of the voltage waveform distortion.
3. Reduction of voltage drop on transformers & cables.
4. Reduction of temperature rise on transformers & cables.
5. Improved power factor.



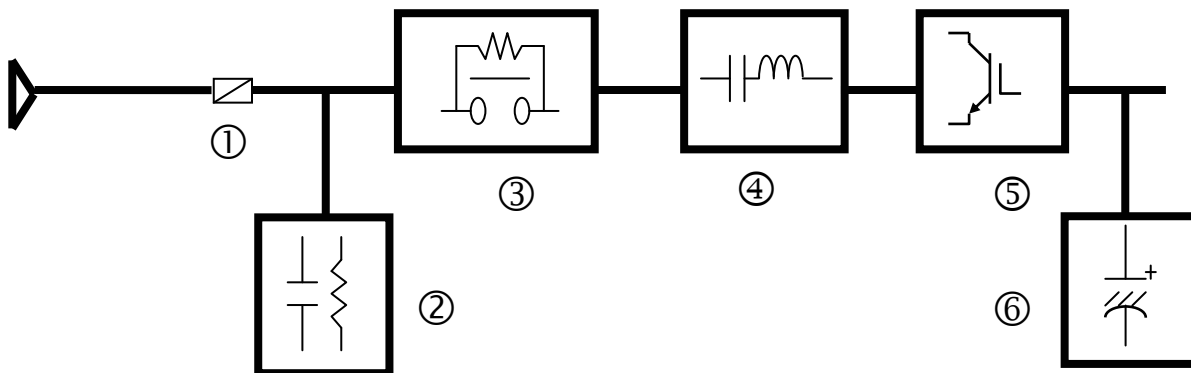
CAUTION!

The AHF is not recommended with a load that has a high rising rate (di/dt) characteristic in terms of current. Such load, such as that of a Rectifier employing phase control with extra low inductance rating, may cause the AHF to stop operating. In certain applications where there is equipment having similar characteristics, such a load will generate high-frequency current. Add a line reactor (minimum 3% impedance) to these loads prior to installing the Active Harmonic Filter. Power factor correction capacitors, certain types of passive harmonic filters, etc., may also affect the normal operation of the AHF or cause it to shutdown.

COMPONENTS

The **ARTECHE** AHF provides three phase harmonic current compensations. The main components of the AHF are as follow:

- A ripple current filter module. This module's main function is to absorb the high frequency ripple current and compensate specific amounts of reactive power.
- A pre-charge electromagnetic contactor module. This module helps to limit the amplitude of the inrush current when DC capacitor set is charging.
- A high frequency inductor-capacitor module. This module acts as the power transmission interface component between power converter and power system.
- An Isolated **Gate Bipolar Transistor (IGBT)** power converter module. This module transforms the harmonic energy from the connected power system and regenerates an equal, but opposite phase shifted harmonic current back to the power system. This regenerated energy will cancel the harmonic produced by the power system.
- A DC capacitor module. This module stores energy taken from the power system before the IGBT Converter can use it to regenerate the opposite phase shifted compensating harmonic current.



- (1) High-Speed Fuse
- (2) Ripple Current Filter Module
- (3) Soft-start Electromagnetic Contactor Module
- (4) High Frequency Inductor-Capacitor Module
- (5) IGBT Power Converter Module
- (6) DC Capacitor Module

BRIEF DESCRIPTION OF COMPONENTS

This section describes the working principles of the main components inside the ARTECHE Type AHF Active Harmonic Filter.

RIPPLE CURRENT FILTER MODULE

The ripple current filter is shunt-connected at the output terminals of the AHF. Its main function is to absorb high frequency ripple current and provide specific amounts of reactive power compensation. Its main components consist of the following:

- Parallel/Series link resonance filter.
- Over-current protection relay (OL1).
- Abnormal trip control device.

Under the normal working condition, the ripple current filter will also provide partial reactive power factor to improve lagging power factor.

The over-current protection relay (OL1) is incorporated to protect the AHF. A malfunctioning IGBT power converter may generate a large amount of high frequency current into the ripple current filter. This will cause the over-current protection relay to trip, thus shutting down the AHF system to prevent further damage to the entire the AHF system.

PRE-CHARGE ELECTROMAGNETIC CONTACTOR MODULE

The main function of this module is to inhibit inrush current when DC capacitor module is charging. When the voltage of the DC capacitor reaches its default value, the AHF will then be switched on to its normal operating mode. The main components for pre-charge electromagnetic contactor are as followings:

- Current-limiting resistor
- Electromagnetic contactor

This module inhibits the inrush current going through the IGBT power converter into the DC capacitor module within a certain level. After switching on the AHF, the electromagnetic contactor will close to make the IGBT power converter truly connected with the power system and bypasses the current-limiting resistor.

High Frequency Inductor-Capacitor Module

The inductor and capacitor are the power transmission interface components between the IGBT power converter and the connected power system. It also compensates the reactive power for the lagging power factor.

The main components of the High Frequency Inductor-Capacitor Module are:

- High frequency response inductor.
- High frequency response capacitor.
- Current transformer.

The current transformer is used to feedback the harmonic compensating current to a control circuit, this will allow the AHF to perform high-speed compensation and ensure a current-limit if the harmonic energy exceeded its capacity.

IGBT POWER CONVERTER MODULE

The IGBT power converter is the major architecture of the AHF in the cancellation of the harmonic current (I_{Lh}) generated by the connected non-linear load. The IGBT power converter makes use of this harmonic energy (I_{Lh}) as an initial power to produce an opposite phase shifted harmonic current waveform (I_E). This waveform is then re-injected into the connected power system to cancel the existing harmonic distortions (I_{Lh}), ensuring a near perfect sine waveform (I_s) returning to the power mains.

The main components of the IGBT power converter module are:

- IGBTs bridge
- Driver circuit
- Snubbers

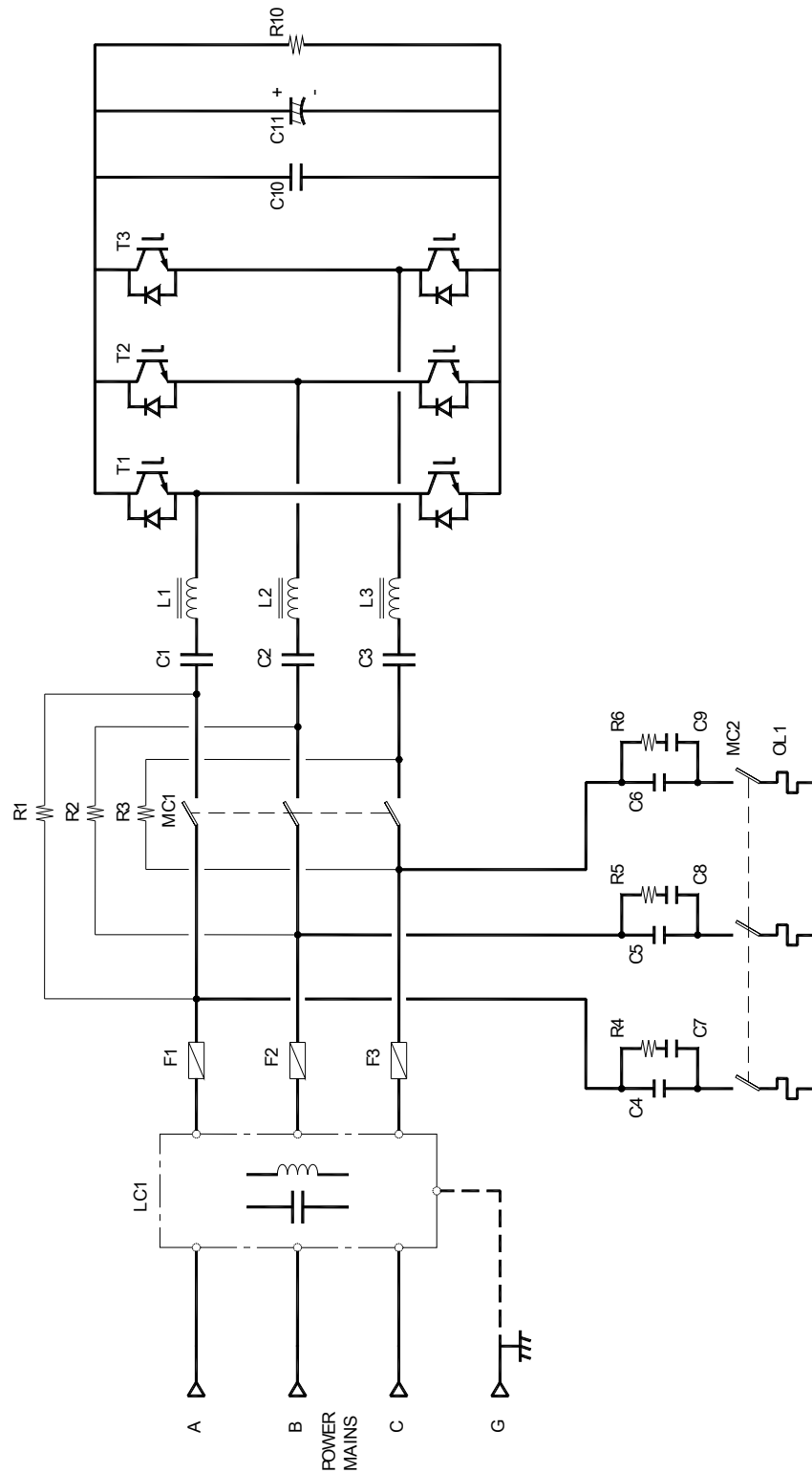
The electronics bridge of the power converter is made up of isolated gate bipolar transistor (IGBT). It utilizes **P**ulse **W**idth **M**odulation (PWM) technology to drive the IGBTs to produce compensating current waveform. Built in snubbers are used with the IGBT for protection from spikes when the power converter is in operation.

DC CAPACITOR MODULE

DC capacitor module stores the energy (I_{Lh}) generated by the connected power system to be used by the IGBT power converter for re-generation of the opposite phase shifted compensating harmonic current waveform (I_E). The storing and releasing of energy of the DC capacitor module is electrically control by the IGBT power converter.

The DC capacitor module is made up of specific numbers, with similar rated DC capacitors connected electrically in parallel.

SYSTEM STRUCTURE SCHEMATIC DIAGRAMS



Drawing 1-1 AHF System Structure Schematic Diagram

CHARACTERISTICS & SPECIFICATIONS

GENERAL CHARACTERISTICS

Equipment storage temperature	-20°C to +70°C
Operating Temperature	+12°C to +25°C (Recommended Range), + 0°C to +40°C (Tolerated Range)
Relative Humidity	< 95%
Operating Altitude	< 1000 m
Reference Harmonic Standard	EN 61000-3-4 , IEEE 519-1992
Reference Design Standard	EN60146
Safety Standard	EN50178, UL508, CUL508
Electromagnetic Compatibility	EN55011, EN50081-2, EN61000-4-2, EN61000-4-3, EN61000-4-4, EN61000-4-5, EN61000-4-6, EN61000-6-2, FCC Part 15, ANSI C62.41, IEEE587

MECHANICAL SPECIFICATION

Filters rated above 200 amps (shaded area) are supplied as multiple units of lower current rated filters.

This table indicates how the high current filters are constructed.

Filter Rating	Actual Filter Units	Style	Height (inches)	Width (inches)	Depth (inches)	Weight (pounds)
25	1 x 25A	Wall	36	16.2	15.4	121
50	1 x 50A	Wall	36	16.2	15.4	154
100	1 x 100A	Floor	78	24	32	595
150	1 x 150A	Floor	78	24	32	661
200	1 x 200A	Floor	78	48	32	1190
250	1 x 100A and 1 x 150A	Floor	78	48	32	1256
300	2 x 150A	Floor	78	48	32	1322
400	2 x 200A	Floor	78	96	32	2380
450	3 x 150A	Floor	78	72	32	1983
600	4 x 150A	Floor	78	96	32	2644
750	5 x 150A	Floor	78	120	32	3305
800	4 x 200A	Floor	78	192	32	4760
900	6 x 150A	Floor	78	144	32	3966
1000	5 x 200A	Floor	78	240	32	5950
1200	6 x 200A	Floor	78	288	32	7140

ELECTRICAL SPECIFICATION

Line Voltage	V	208 / 240 / 380 / 415 / 480 (-10%, +15%)
Phase/Wires		AHF series for 3 phase 3 wires
Frequency	Hz	50Hz or 60Hz (± 3 Hz)
Compensated Harmonic Orders		<u>Global</u>: Use this to compensate for all harmonic frequencies from 3rd to 51st. <u>Selective Compensation</u>: Use this for simultaneous compensation for up to four individual harmonic frequencies (3, 5, 7, 11, 13, 17, 19, 23, 25). <u>High Order compensation</u>: compensates 15th – 51st harmonic
Harmonic attenuation ratio		Typical >10 (load current THD% <50%)
Transient Response Time	msec	< 20
Inrush Current		Less than rated current
Current Limitation		Yes, at full correcting amperes
Pre-charge time	Sec	10

Filter Rating	Compensating Current (amps)	Heat Losses (kW)	Audible Noise (1m) (dBA)
25	25	0.55	60
50	50	0.95	60
100	100	2.00	63
150	150	3.00	63
200	200	4.10	65
250	250	5.00	65
300	300	6.00	65
400	400	8.20	65
450	450	9.00	65
600	600	12.30	65
750	750	15.00	65
800	800	16.40	65
900	900	18.00	65
1000	1000	20.50	65
1200	1200	24.60	68

Enclosure Paint : Beige RAL9001 (standard)

COMPENSATION ABILITY

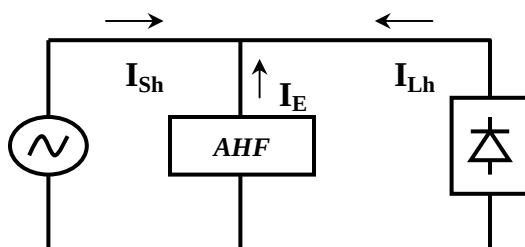
The compensation ability of the AHF is defined in terms of **Harmonic Attenuation Ratio (HAR)**.

$$HAR = I_{Lh} / I_{Sh}$$

HAR : Harmonic attenuation ratio

I_{Lh} : Harmonic current at load side

I_{Sh} : Harmonic current at power source side



Note: All measurements should be carried out when the AHF is functioning normally.

SELECTION

The **ARTECHE**AHF compensates harmonic current automatically. There is no need to measure the impedance of the power system, or analyze the load harmonic spectrum and their individual amplitude. The selection is based on the known estimated load harmonic current amplitude (I_{Lh}) to be compensated, and then select the AHF model which has the output compensating current rating greater than that of the I_{Lh} .

NOTE:

Generally as a rule of thumb, we recommend a 25% higher rating than the I_{Lh} to be compensated. For example, if the known load harmonic current amplitude is 40 Amps, the appropriate rating of the AHF should be 50 Amps.

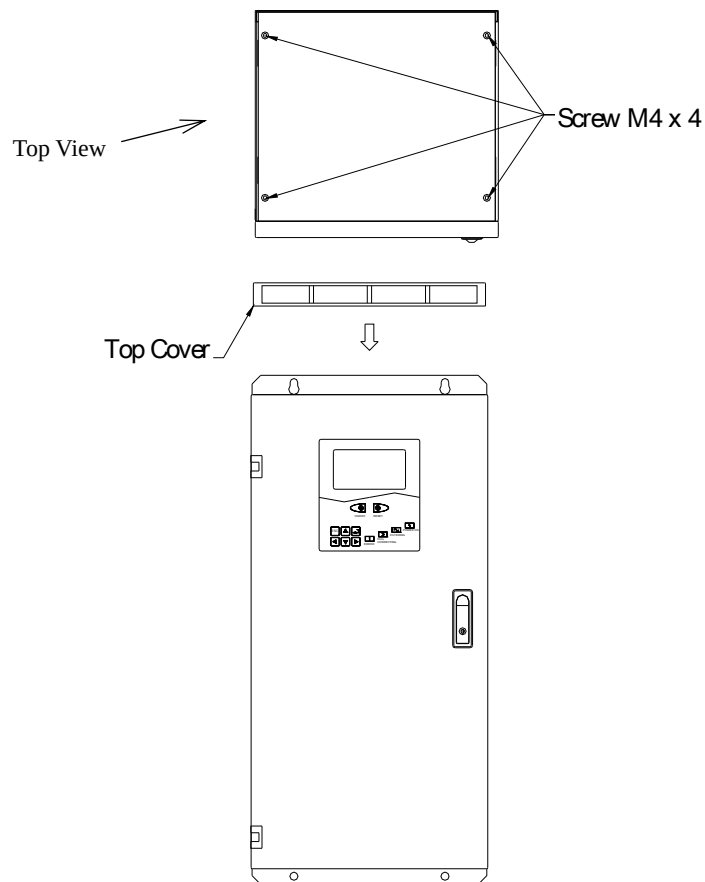
In the event the real values of the I_{Lh} are higher than the estimated one, or the I_{Lh} increases due to additional loads, there is no overload risk on the existing AHF that has been selected. The AHF has current limit capability up to its full rated compensating capacity, thus it will not shut down or malfunction, but will continue to operate in full compensating mode. In such cases, additional AHFs can be added in parallel to meet the increase of the I_{Lh} value. Up to six AHF units can be connected in parallel.

INSTALLATION AND WIRING

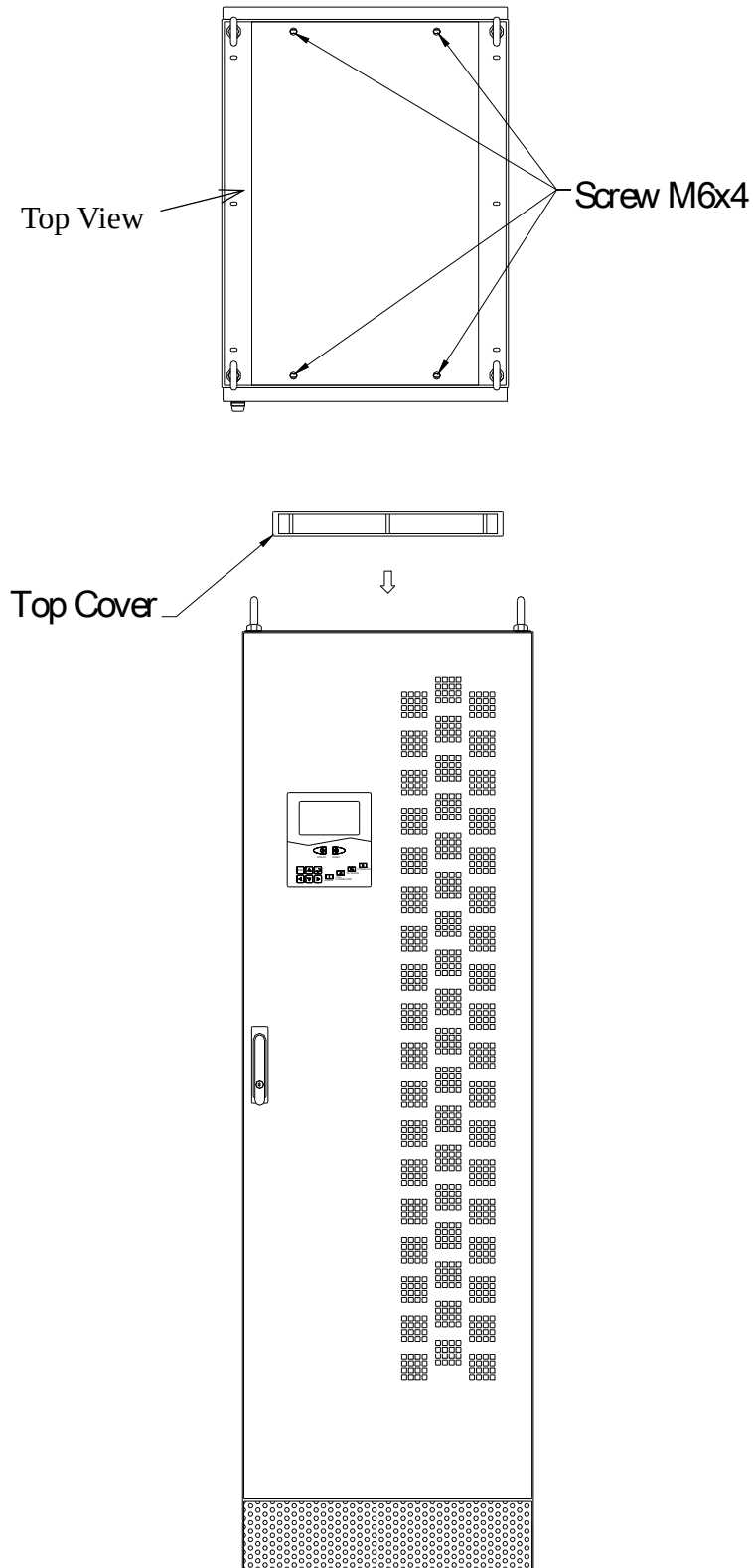
LOCATION AND INSTALLATION

To ensure the proper operation and to enhance the operating life span of the AHF, it is recommended to install the AHF in a dust free environment where temperature and humidity are maintained at the values specified in the characteristics and specification section (page 11). Cooling fans are built-in to dissipate heat from the AHF, it is important to avoid any obstruction to the front, top, and base ventilation louvers of the AHF at all times.

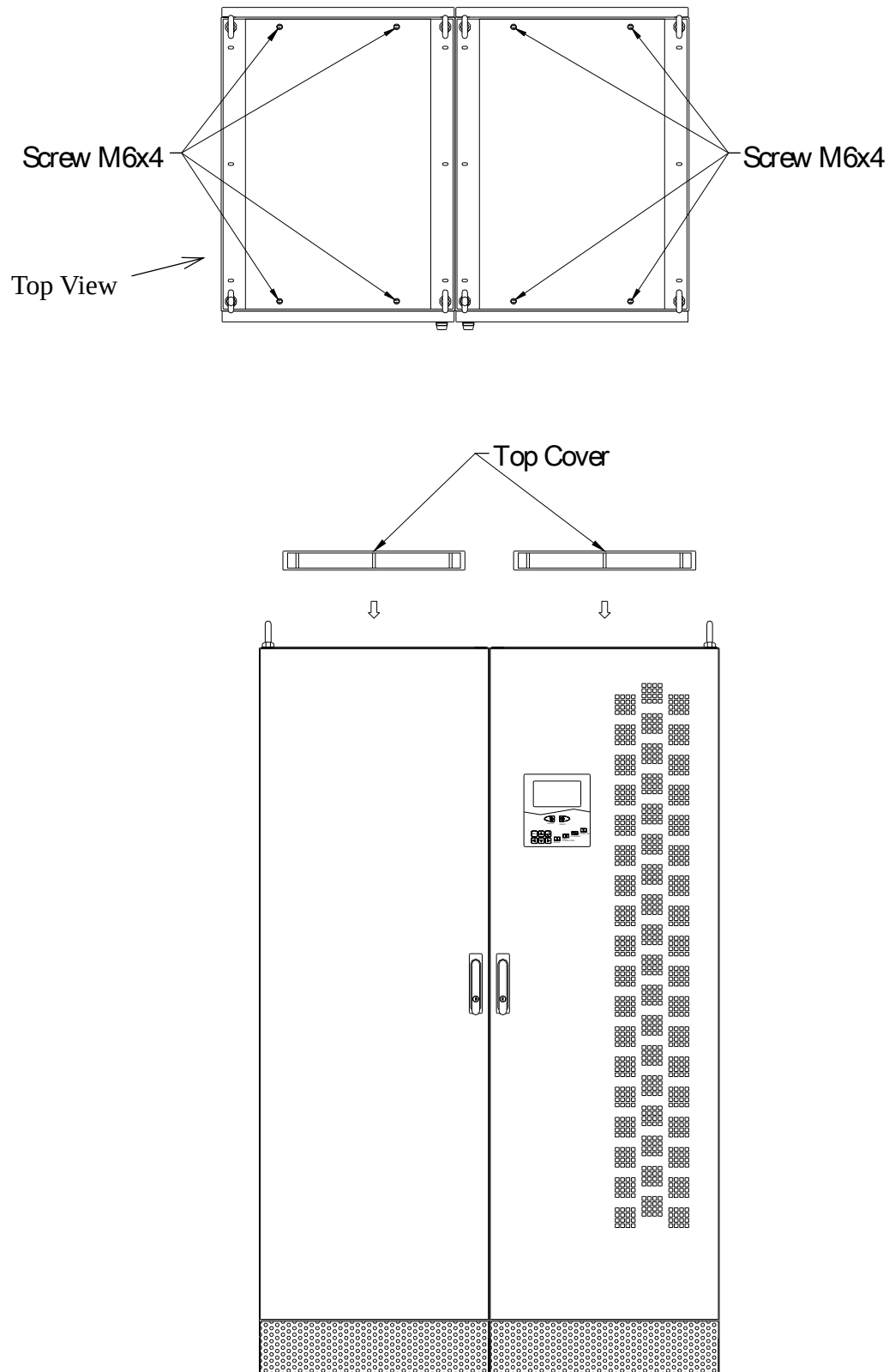
To prevent anything from dropping into the AHF and damaging the components inside, install the top cover and secure it to the enclosure with the screws provided. Drawings 2-1 to 2-3 below shows the installation of the top cover on the various models of AHFs.



Drawing 2-1 Install Top Cover of AHF-0025 & AHF-0050



Drawing 2-2 Install Top Cover of AHF-0100 & AHF-0150



Drawing 2-3 Install Top Cover of AHF-0200

GENERAL REQUIREMENT FOR VENTILATION & MAINTENANCE

Be sure to follow all national and local electrical codes and clearance requirements.

To allow proper air circulation and maintenance of the equipment, always allow minimum clearance:

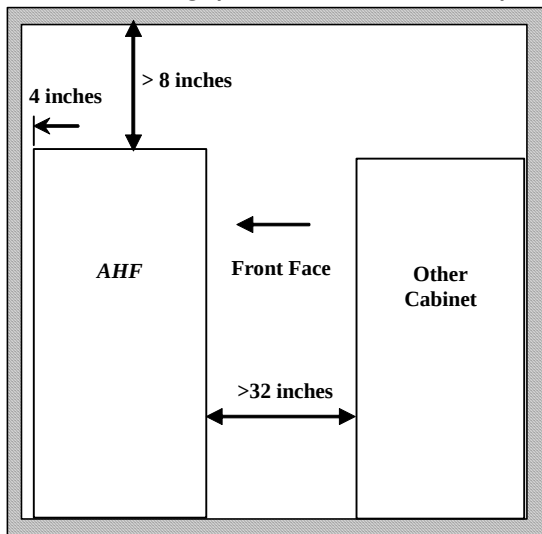
For Floor Standing AHF

- Four inches between the rear of the AHF cabinet and the wall
- Minimum eight inches from the top of the AHF cabinet to the ceiling
- Minimum 32 inches from the front of the AHF cabinet to the wall or other equipment cabinet

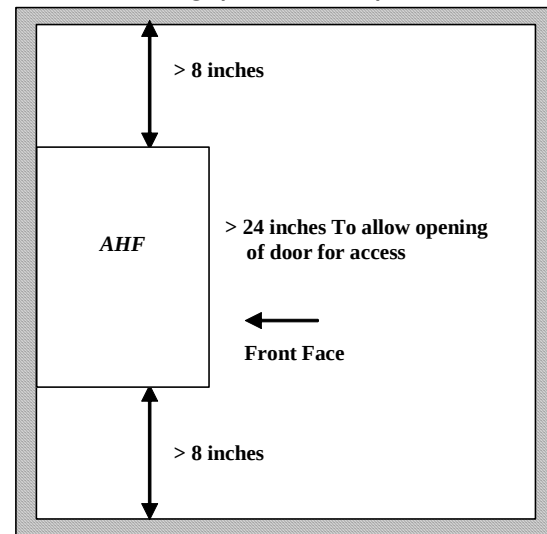
For Wall Mounting AHF

- Minimum eight inches from the top of the AHF cabinet to the ceiling
- Minimum eight inches from the base of the AHF cabinet to the flooring
- Minimum 24 inches from the front of the AHF cabinet to the wall or other equipment cabinet

Floor Standing (100A, 150A & 200A)



Wall Mounting (25A & 50A)



WIRING CONNECTION

Cable requirements for the **ARTECHE**AHF are:

- Power cables, to be connected to power terminal block Q1.
- Grounding cable, to be connected to ground terminal (bar).
- CT output lines, to be connected to current signals terminal bar (TB1).

The recommended ideal wiring connections are as shown in drawing 2-4. All CTs are connected on Load side to detect load harmonic current for optimum filtering. **Using this factory default connection, the changeover switch SW1-1 on Board APJ15 must be set on "Load" position.**

Drawing 2-5 shows the connections of the CTs on Power Source side when the connections on Load side are not possible. This method of connection may not provide optimum filtering as compared to the connection shown in drawing 2-4. **Using this connection, the changeover switch SW1-1 on Board APJ15 must be set on "Source" position.**

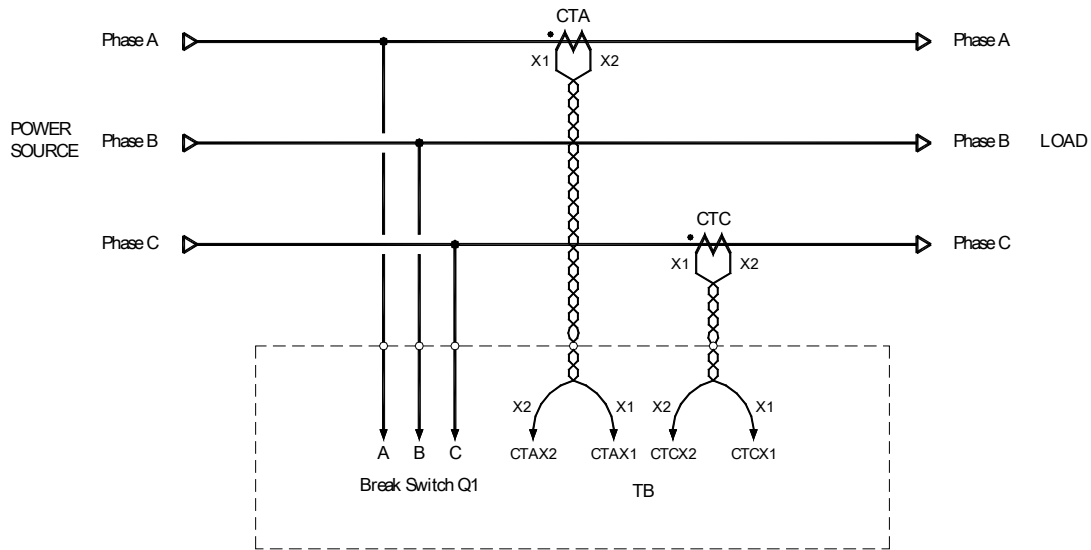
 CAUTION!	To avoid possible interference with the CT output signal, do not place Power Cables and the CT twisted paired signal cable in the same tray or conduit. If both Power and Signal cables need to be in the same tray or conduit, ensure proper partitions are in place to provide isolation between them.
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The appropriate ratings of power cables and over-current protection devices are required for use in conjunction with the AHF. These devices should adhere to local electrical regulations and the technical descriptions provided by the original equipment manufacturer. In addition, a minimum 10% over sizing to the Power Cables size and Over-Current Protection Devices is recommended, due to "skin effect" caused by the compensating harmonics generated by the compensating harmonics generated by the AHF.

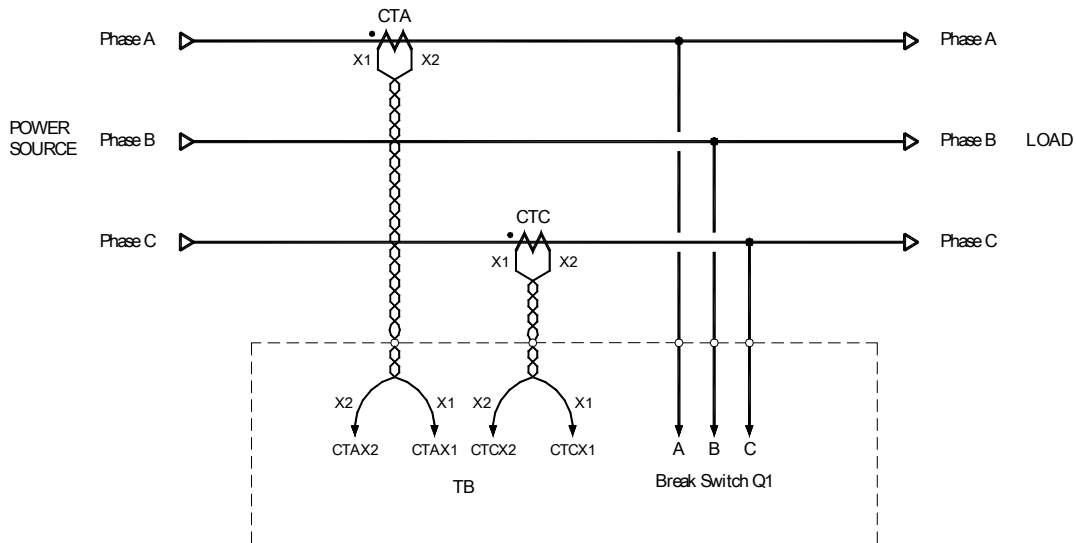
The ARTECHE AHF may not perform properly if power-factor correction capacitors are connected to the AC-bus down-stream from the current transformers (CT's). In addition to stand-alone connection, power factor capacitors may be enclosed in equipment. Refer to site on-line diagrams/equipment schematics to verify their absence.

For proper performance the following points must be observed:

- The phase sequence of the 3-phase power wires feeding the StacoSince AHF must be positive sequence. i.e. a phase rotation meter should indicate "clockwise".
- DC-drives must have a 3-phase AC reactor (3% minimum) or a drive isolation transformer inserted between the ARTECHE AHF connection point and the drive AC input.
- Variable-frequency AC-drives must have a 3-phase AC reactor (3% minimum) or drive isolation transformer with electro-static shielding inserted between the connection point and the drive AC-input, unless the drive is a PWM type drive with a diode rectifier and has a DC-bus reactor incorporated. In that case ARTECHE AHF may be connected directly to the drive AC input terminals.



Drawing 2-4 2CTs Wiring Schematic Diagram at Load Side for the AHF



Drawing 2-5 2CTs Wiring Schematic Diagram at Source Side for the AHF

CONNECTING LAYOUT & SPECIFICATION

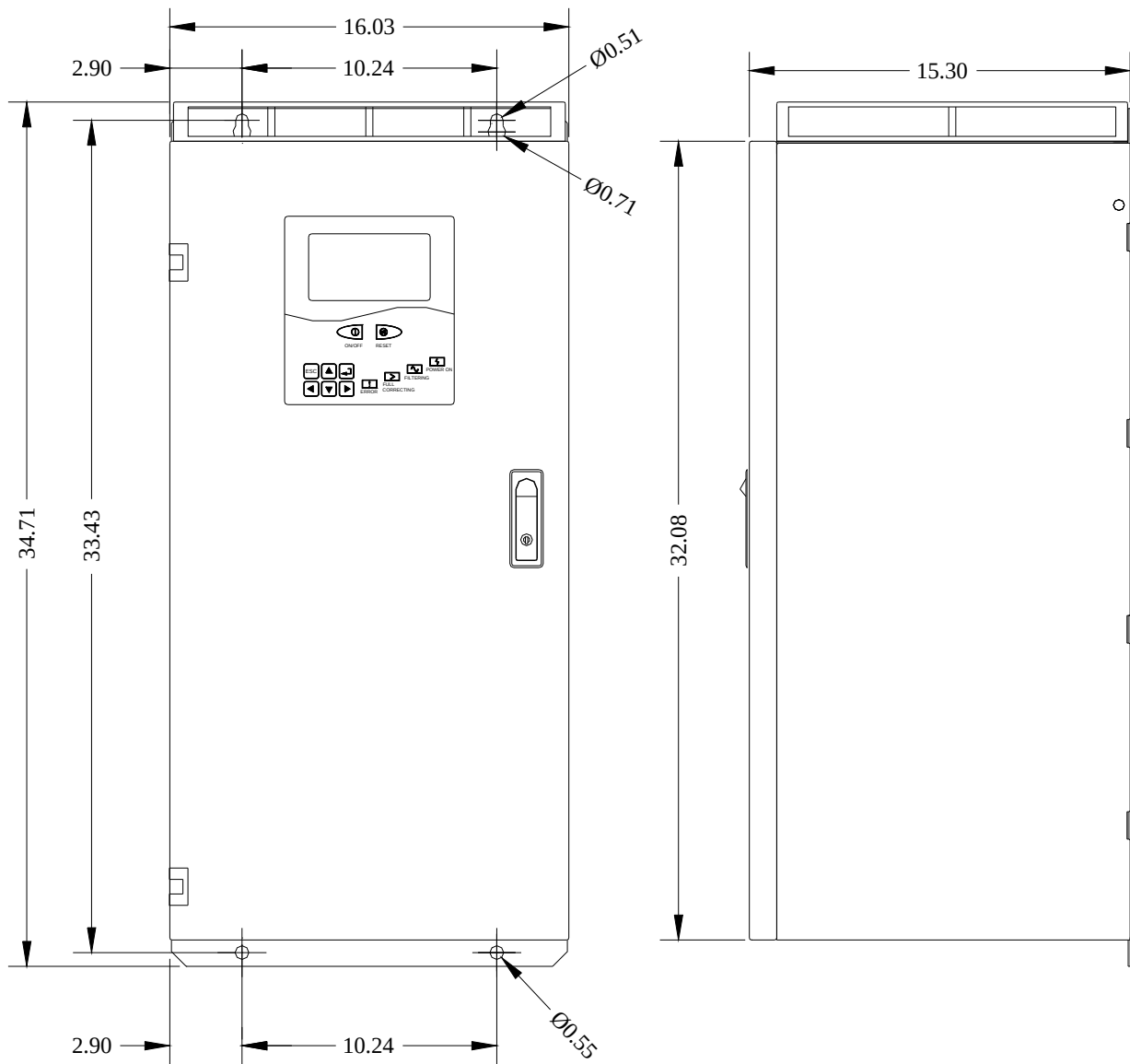
All cable entries are from bottom of the AHF cabinet. The table below shows the type of terminals and their maximum allowable cable size capability.

Amp Rating	Connection to power terminal block Q1, allowable cable size	Ground connection type and cable size	Torque In. Lb.
25	Crimping, minimum 6AWG 75°C, maximum 4 AWG	Grounding screw, M6 minimum 8AWG 75°C	26.5
50	Crimping, minimum 6AWG 75°C, maximum 4 AWG	Grounding screw, M6 minimum 8AWG 75°C	26.5
100	Crimping, minimum 1/0 AWG 75°C, maximum 3/0 AWG	Grounding copper bar, M8 minimum 6AWG 75°C	150
150	Crimping, minimum 1/0AWG 75°C, maximum 3/0 AWG	Grounding copper bar, M8 minimum 6AWG 75°C	150
200	Crimping, minimum 2/0AWG 75°C, maximum 3/0 AWG	Grounding copper bar, M8 minimum 4 AWG 75°C	150

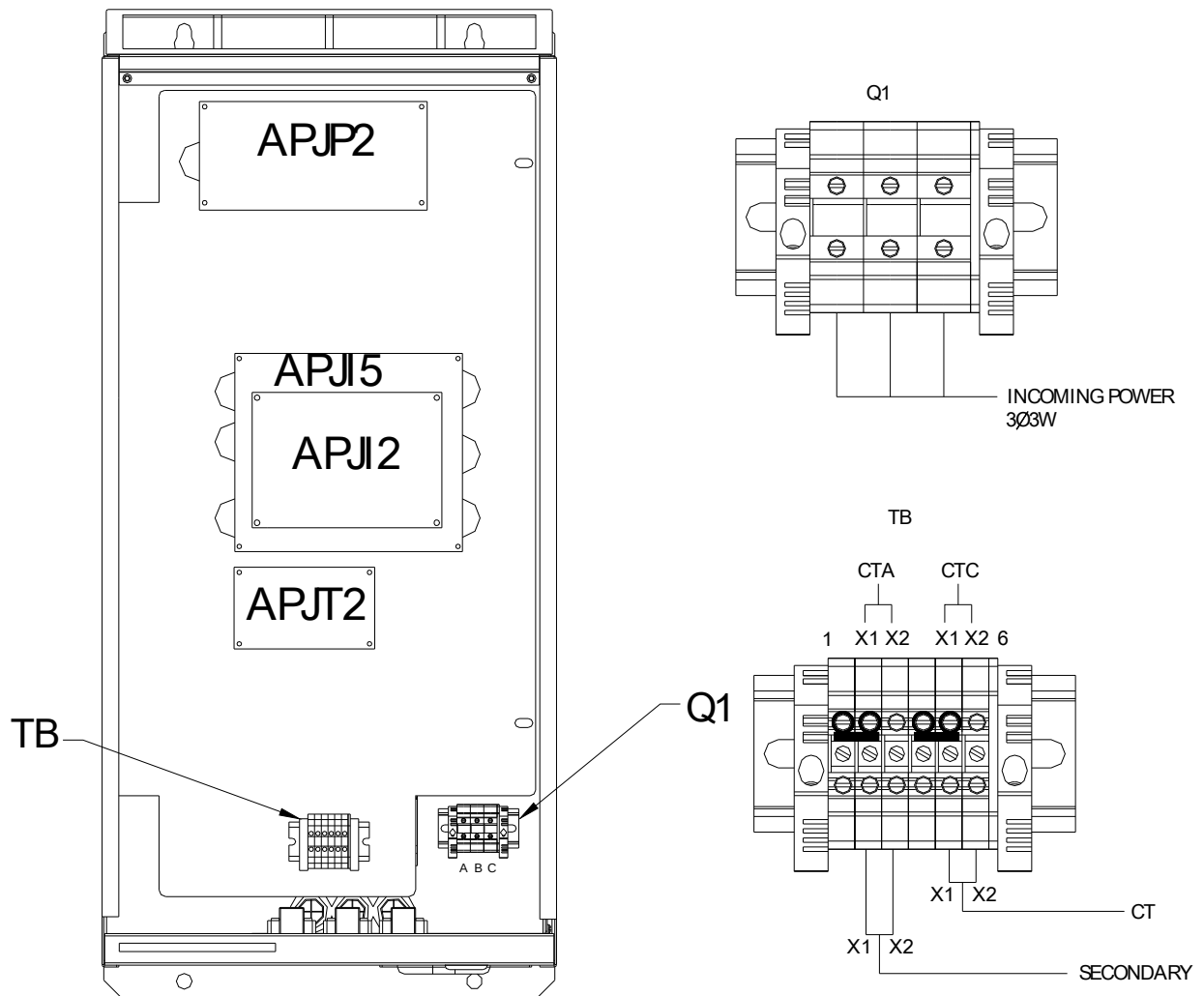
NOTES:

- 1) All high current filters utilize multiple units of lower current rated filters.
- 2) Wiring is to be made to individual filters.

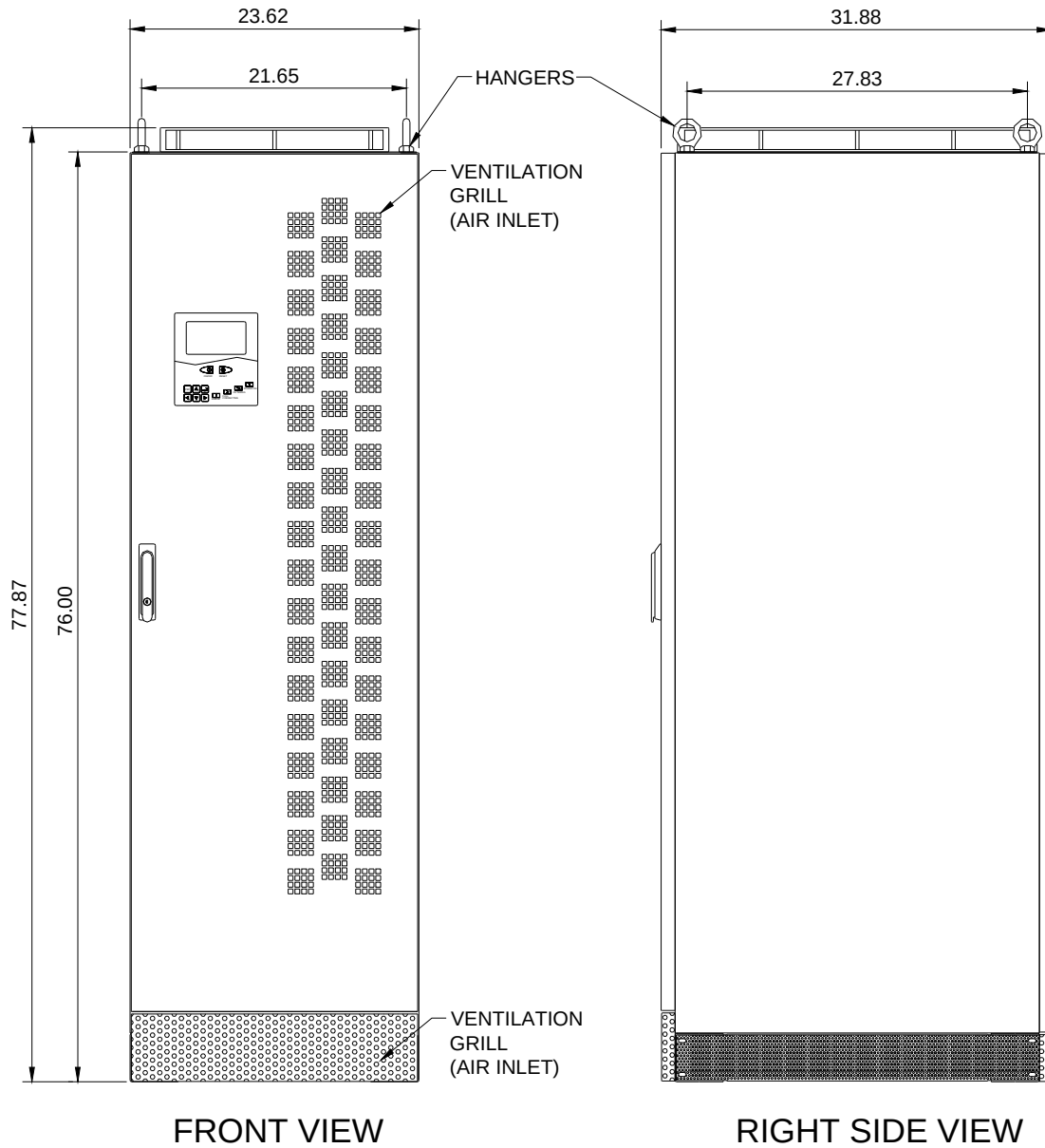
Drawings 2-6 to 2-14 below show the physical dimensions and connection terminals layout of various AHFs.



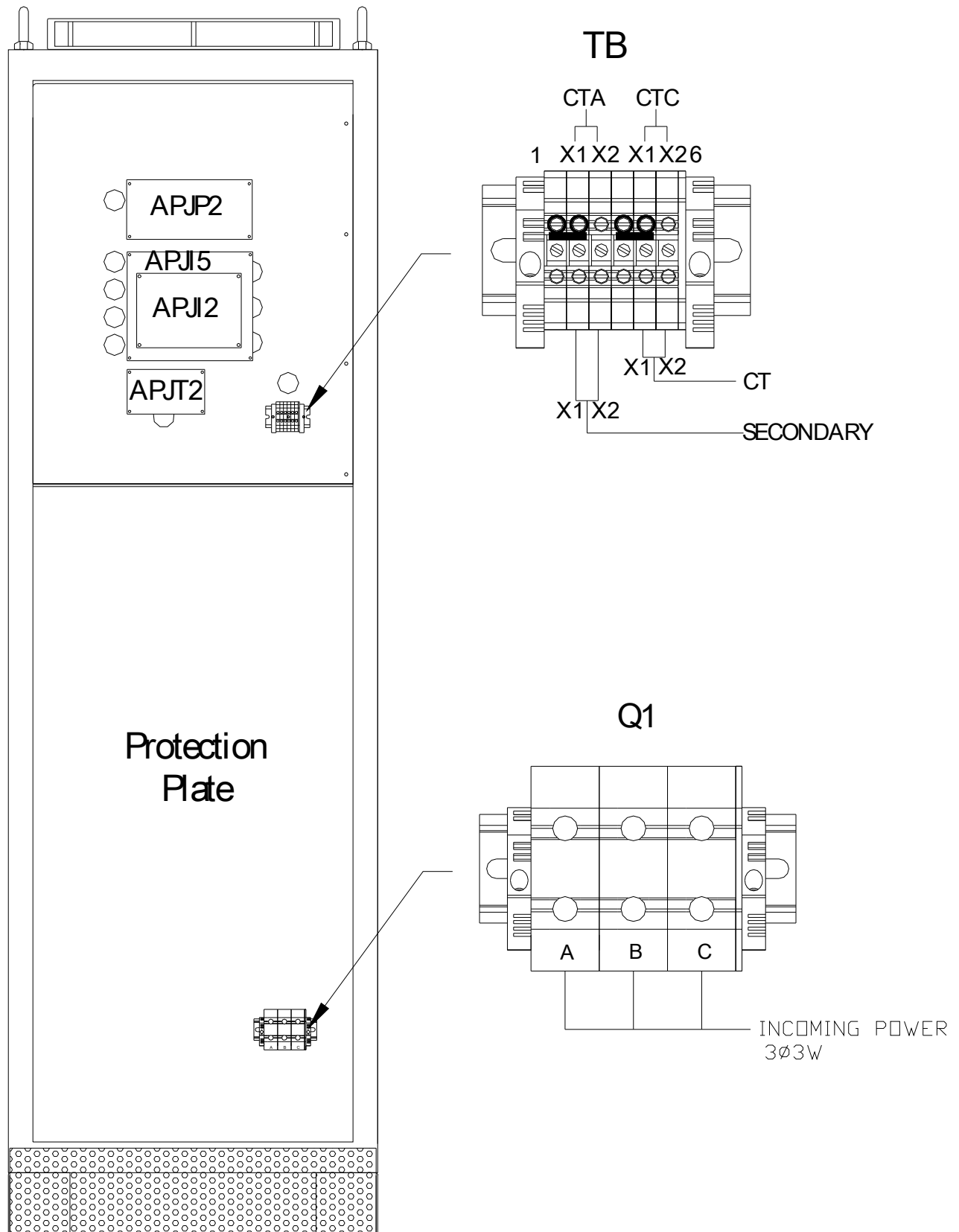
Drawing 2-6 AF-0025 & AF-0050 with LCD Control & Display Panel Physical Appearance Dimensions Diagram



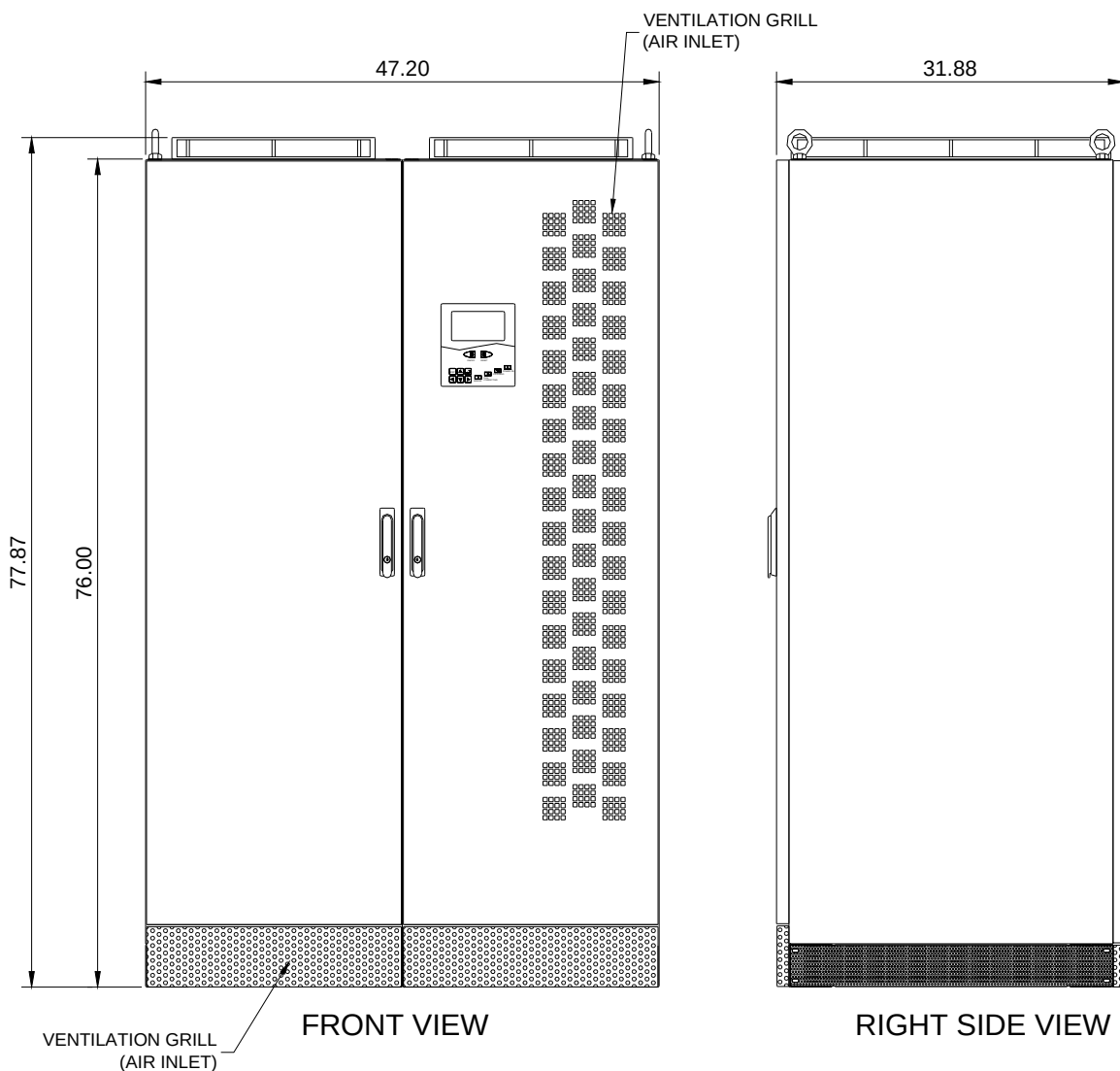
Drawing 2-7 AF-0025 & AF-0050 Wiring Position Schematic Diagram



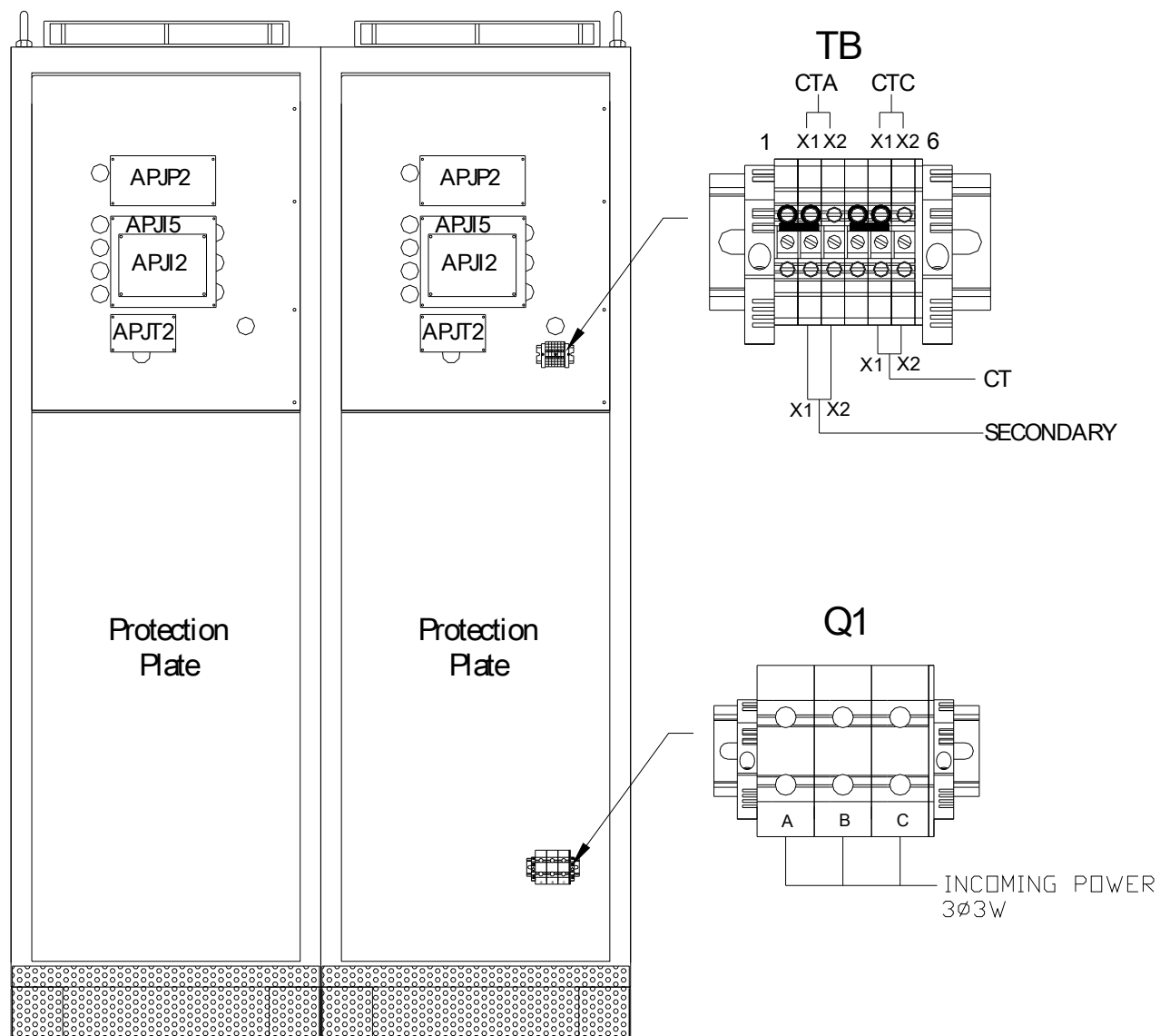
Drawing 2-8 AF-0100 & AF-0150 with LCD Control & Display Panel Physical Appearance Dimensions Diagram



Drawing 2-9 AF-0100 & AF-0150 Wiring Position Schematic Diagram



**Drawing 2-10 AF-0200 with LCD Control & Display Panel Physical Appearance
Dimensions Diagram**



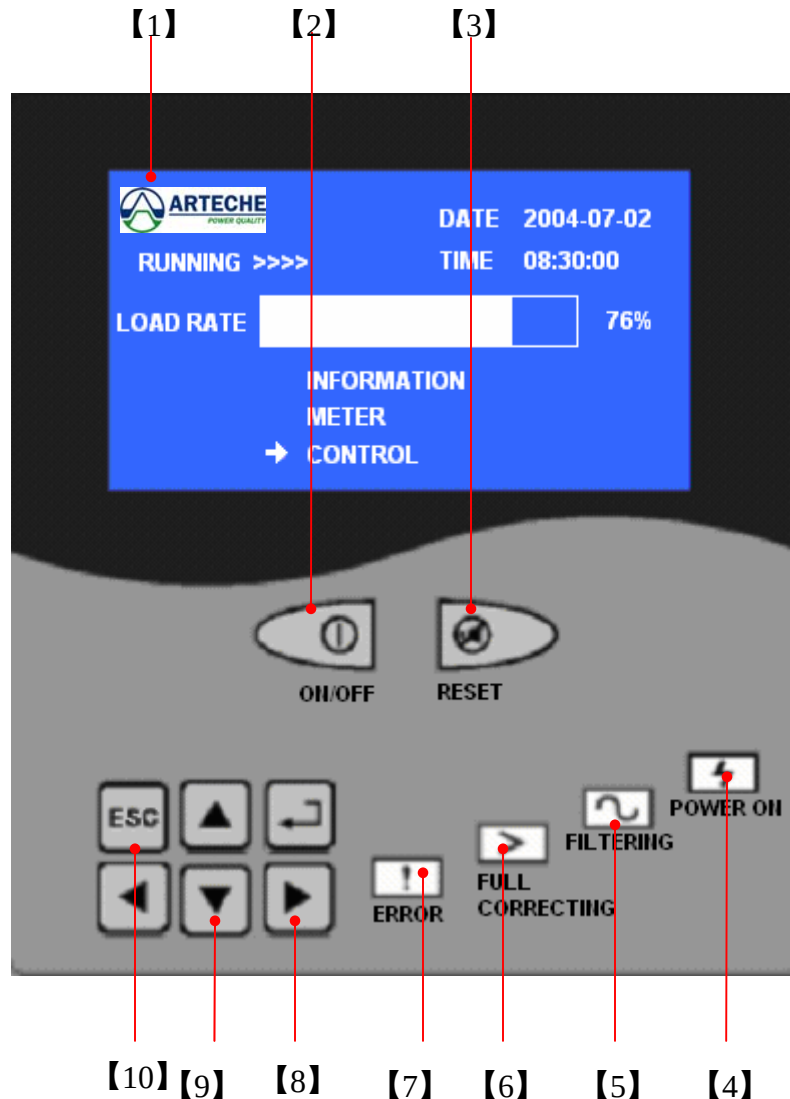
Drawing 2-11 AF-0200 Wiring Position Schematic Diagram

OPERATION

CONTROL PANEL

Summary

Each **ARTECHE** AHF is equipped with a control panel located on the front panel of the cabinet enclosure. The control panel allows a “Man-Machine” interface for operation control and provides the user with data, status, and alarm information.



Drawing 3-1 Control Panel Diagram

- | | |
|---------------------------------|------------------------------|
| 1. Display Screen | 6. Full Correcting Indicator |
| 2. On/Off Keypad | 7. Error Indicator |
| 3. Reset (Alarm Silence) Keypad | 8. Confirmation/Enter Key |
| 4. Power On Indicator | 9. Directional Scrolling Key |
| 5. Filtering Indicator | 10. Escape/Cancel Key |

FUNCTIONAL DESCRIPTIONS

The control panel is made up of eight control keypads, four LED indicators, and one graphic LCD, which provide the following functions:

- Turning ON/OFF the AHF
- Clearing error status and silencing audible alarms
- Display all operating status

Refer to LCD control and monitor panel User's Manual (Form No. 003-2242) for complete information on the AHF control panel.

CONTROL PANEL LED INDICATORS STATUS DESCRIPTIONS



Red LED indicator is **on**: indicates that the control logic circuits of the AHF are energized.



Green LED indicator is **on**: indicates that the AHF is providing the harmonic compensating current to the load. This indicator light will switch off when the AHF is shut down by the user or a system malfunction.



Yellow LED indicator is **on**: indicates that the load harmonic current is greater than the rated AHF compensating current. At this time, the AHF should be in current limit and continue to compensate the load harmonic up to its rated value.



Red LED indicator is **on**: indicates that there are some possible external abnormal conditions or internal abnormal breakdown. The AHF has stopped providing any harmonic compensating current.

START-UP PROCEDURES

After completing all necessary electrical connections, please check:

- The AHF is correctly grounded
- Ensure all of the CTs are connected with the correct polarity
- The power system voltage is within the AHF 's tolerance

After the above conditions are checked, execute the following procedures:

1. Turn on utility power, allowing DC capacitor module to charge.
(Note: After 30 seconds, the DC capacitor module should finish pre- charging)
2. Perform the following checks before proceeding to step 3:
 - Ensure 'POWER ON' LED (red) indicator is *on*
 - Ensure that the cooling fans inside the AHF are operating
 - LD1, LD2, LD3, LD4, and LD5 on Board APJI2 inside the AHF should be *on*. LD1 to LD10 on Board APJI5 should be *off* when all connections are properly made and the AHF is functioning normal.

(Note 1: If APJI5 LD9 Light is On, CT A polarity is incorrect and should be reconnected; if the LD10 Light is On, CT C polarity is incorrect and should be reconnected.)

(Note 2: If APJI5 LD7 Light is On, the phase sequence is incorrect and should be reconnected.)

(Note 3: If filtering, full correcting, and error LED indicators on the control panel are flashing, and APJI5 LD8 light is on, the communication cable is disconnected between the control panel and APJI2. Please check that the communication cable is connected properly).

3. Press the control keypad 'ON/OFF' for two seconds, and confirm the following:
 - 'POWER ON' LED (red) indicator lights is on
 - 'FILTERING' LED (green) indicator lights is on. If this LED is flashing, the AHF accepted the turn-on command already and the DC capacitor module is still under soft-start charging.

(Note: At this stage, an audible noise can be heard from the IGBT power converter module indicating it is in operation).

4. The AHF is now in full operation, providing harmonic compensation to the power system. To ensure the harmonic distortion is being rectify, perform the following:
- Measure and record the harmonic current on each phase at the load side.
 - Measure and record the harmonic current on each phase at the power source side.

Calculate the **H**armonic **A**ttenuation **R**atio (HAR). The compensation ability of the AHF is defined in terms of HAR.

Harmonic Attenuation Ratio

$$= \frac{\text{Harmonic current at load side (I}_{Lh})}{\text{Harmonic current at power source side (I}_{Sh})} > 10$$

SHUTDOWN PROCEDURES

 CAUTION!	Shutting down the AHF should only be carried out during repairing or major maintenance of the entire power system to ensure minimum disruption to critical operation connected to the power system.
--	---

The following shutdown procedures should be performed only by authorized personnel:

1. Press the control keypad 'ON/OFF' for one second, only 'POWER ON' LED (red) indicator should remain on.
2. Turn off utility power to complete the shutdown procedures.

 DANGER	Before performing the actual repair to the AHF, wait at least for three minutes to ensure any residual current and voltage has been completely discharged from the DC Capacitors Module.
--	--

SILENCING THE ALARM

The AHF control panel provides both audible and visual alarms during abnormal system conditions or malfunctions. The alarm buzzer can be silenced by pressing the control keypad **'RESET'** for two seconds. The **'ERROR'** indicator (red) LED remains on until the fault is cleared.

CLEARING THE ERROR STATUS

The AHF will shut down automatically when it encounters errors or faults. Some errors or faults are temporary and the AHF will resume normal operation when these errors/faults disappear. However, some errors/faults are critical and will cause the AHF to permanently shutdown. In order to resume normal operation, the error/fault status need to be cleared after repairs are made.

To clear off the error/fault status:

Press the control keypad '*RESET*' for two seconds to silence the alarm.

The following chart shows the LED indicators on board APJ15 inside the AHF with reference to the probable errors/faults descriptions and the corrective actions.

Chart 3-1 Board APJ15 LEDs Indicator Chart

LED #	Indicator Color	Error/Fault Descriptions	Corrective Action
LD1	Red	Pre-charge electromagnetic contactor module faulty. The contactor switch (MC1 or MC2) tripped or malfunction. The AHF shuts down automatically.	Clear off the error status following procedure stated above. Restart the AHF. If the problem persists contact factory or authorized service agent.
LD2	Red	IGBT module over temperature. The AHF shuts down automatically.	Cooling fans may be faulty. Clear off the error status by following procedure stated above. Restart the AHF. Pay attention to the mechanical sound when the fans start up. If the fans fail to start up or produce abnormal mechanical noise, shut down the AHF. Contact local factory or authorized service agent.
LD3	Red	Over current relay (OL1) tripped. Ripple current filter module is overloaded. The AHF shuts down automatically.	This may be caused by a source voltage distortion or the AHF IGBT fault. Clear off the error status following procedure stated above. Restart the AHF. If the problem persists, contact factory or authorized service agent.
LD4	Red	System voltage is abnormal. The AHF shuts down automatically.	The AHF will turn on automatically when the system voltage is normal.

LED #	Indicator Color	Error/Fault Descriptions	Corrective Action
LD5	Red	The output current of IGBT power converter module happen high frequency resonance. The AHF shuts down automatically.	The loads may be over capacitive. Clear off the error status by following the procedure stated above. Restart the AHF. If the problem persists, contact factory or authorized service agent.
LD6	Red	DC bus over-voltage. The AHF shuts down automatically.	The AHF will turn on automatically when the DC bus voltage is under 380V.
LD7	Red	Phase sequence incorrect or frequency over specification. The AHF will not start up from operation or shuts down automatically.	Ensure the power cable is connected in the correct phase sequence, if not the power cable should be reconnected. The AHF will turn on automatically when frequency is normal.
LD8	Red	Communication is disconnected between control panel and PCB APJ12.	The control panel is not functioning. Check that the communication cable is connected properly.
LD9	Red	Filtering off, the current Transformer A (CT A) polarity is incorrect.	CT A should be reconnected.
		When filtering on and phase A harmonic load current is greater than the AHF rated capacity. The full correction LED indicator on the control panel will also light up, indicating that the AHF is in current limit condition.	The AHF capacity is under rated to compensate the harmonics present. Use a harmonic analyzer to confirm the real value of the harmonics. Upgrade the AHF capacity or install additional units parallel with the existing the AHF.
LD10	Red	When filtering off the current transformer C (CT C) polarity is incorrect.	CT C should be reconnected.
		When Filtering On and Phase C harmonic load current is greater than AHF rated capacity. The full correction LED indicator on the control panel will also lights up, indicating that the AHF is in current limit condition.	Same as Above
LD11	Red	CN12 on APJ15 is connected correctly.	CN12 Just using in AF-0200.

ON SITE TUNING PROCEDURES FOR OPTIMUM PERFORMANCE

The following inspections must be carefully checked prior to any tuning of the AHF:

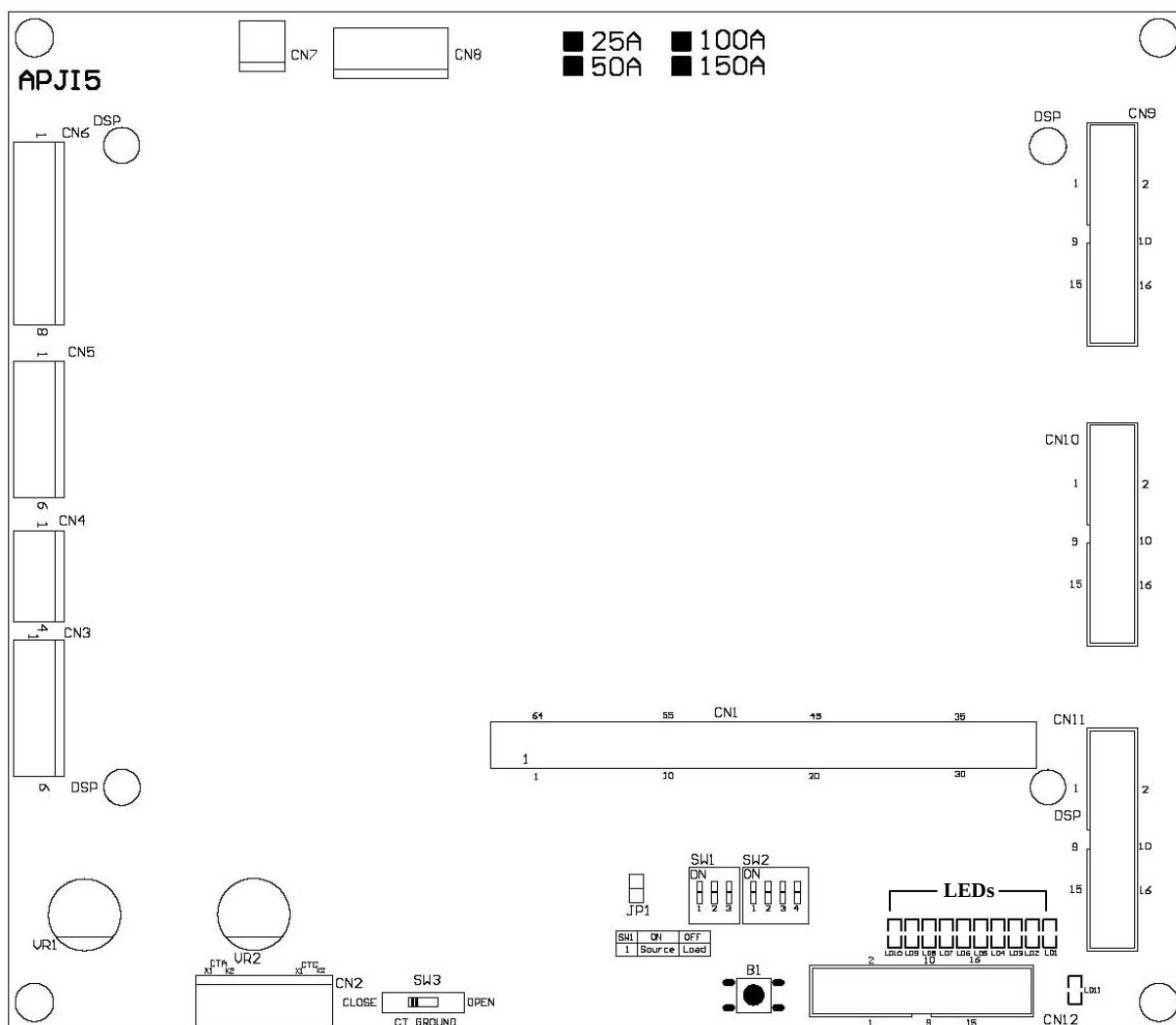
1. The changeover switch SW1-1 on Board APJ15 must be set to the correct position according to the CTs location; refer to section – Wiring Connection of this manual. The factory default setting is for “LOAD”.
2. If other equipment also uses CTA and CTC, the changeover switch SW3 on board APJ15 must be set to the “OPEN” position. The factory default setting is for “CLOSE”.
3. Make sure that both power cables and the CT twisted paired signal cables are not placed in the same tray or conduit.
4. Make sure that the CTs have been connected to the proper phases, CTA should be on phase A and CTC should be on phase C; please refer to section – Wiring Connection of this manual.
5. Make sure that the connections of CTs are not out of phase; please refer to section – Wiring Connection of this manual. (If the connection of CTA is out of phase, then the LD9 on board APJ15 will light up. If the connection of CTC is out of phase, then the LD10 on Board APJ15 will light up).

The following are on site tuning procedures for the AHF:

1. Turn on the harmonic load.
2. Perform the start-up procedures as per section – Start-Up Procedures of this manual.
3. Measure the THDI of Phase A on source side;
If the reading THDI value is near to the targeted value, adjust VR1 on Board APJ15 until the THDI reading is minimum value.
4. Measure the THDI of Phase C on source side;
If the reading THDI value is near to the targeted value, adjust VR2 on Board APJ15 until the targeted THDI reading is achieved.
5. The THDI reading of Phase B should be automatically reduced to minimum value after the above procedures have been performed.

Note: The main function of VR1 and VR2 is correcting the CTA and CTC tolerance. If the reading THDI value is quite different from the targeted value; please contact local authorized service agent.

Drawing 3-2 shows the positions of LED Indicators and Switches on PCB APJ15.



Drawing 3-2 The Positions of LEDs and Switches on PCB APJ15

FUNCTION SETTING

This section describes the AHF setting functions, including the AHF current ratings, CT locations, harmonic compensation configurations, and smart save energy mode. The parameters setting and configuration are put on the SW1 & SW2 on Board APJ15.

The AHF can effectively compensate harmonics, from the 3rd to 51st order. The compensated settings are divided into three categories as followings;

1. Individual Selective Compensation: The 3, 5, 7, 11, 13, 17, 19, 23, and 25 harmonics can be selected individually. A maximum of four orders can be enabled simultaneously.
2. Higher-order Group Compensation: Compensate simultaneously higher-order harmonics from the 15 to 51 components.
3. Reactive Compensation Mode: Disable harmonic compensation and only provide reactive power.

The harmonic compensation mode setting description are shown on the chart 3-3 of this manual.

The **Energy Saving** mode provides the function of automatic start-up and shutdown, according to load current level. When load harmonic current is less than minimum-off current level, the AHF will shutdown automatically until the load harmonic current is greater than maximum-on current level. The minimum-off current level of the factory default setting is 5% of the AHF current rated. The maximum-on current level of the factory default setting is 10% of the AHF current rated. Refer to the chart 3-3 of this manual.

CONFIGURATION PROCEDURES OF MODIFYING HARMONIC SELECTION compensation:

The following are configuration procedures for harmonic selection compensation for the AHF:

1. Press the control keypad '**ON/OFF**' for one second to shutdown the AHF, only the '**POWER ON**' LED (red) indicator should remain on.
2. Close the jumper JP1 on board APJ15.
3. Press button S2 on board APJ12 for one second to reset the controller of the AHF.
4. Check the five LEDs from LD1 to LD5, on board APJ15 light are on. This indicates the AHF controller is ready for the configuration mode.
5. Open the jumper JP1 on board APJ15.

6. Determine the AHF current rating, and then refer to the chart 3-2 and set SW1 on board APJI5.
7. Refer to the chart 3-3 of this manual, and then set SW2 on board APJI5 to select the desired harmonics compensation.
8. Press button B1 on Board APJI5 until the 5 LEDs, from LD5 to LD1, on Board APJI5 turn off sequentially. This indicates the new configuration parameters are effective.
9. Operate the control panel to turn on the.

Chart 3-2 SW1 Setting

CT Location	Rated Current	25A 50A 100A 150A	200A
	Load	ON ☐ ☐ ☐ 1 2 3	ON ☐ ☐ ☐ 1 2 3
	Source	ON ☐ ☐ ☐ 1 2 3	ON ☐ ☐ ☐ 1 2 3

☐ : ON ☐ : OFF

Chart 3-3 Harmonic Compensation Setting Description (SW2 Setting)

SW2 Setting				Setting Description
1	2	3	4	
X	ON	ON	ON	3, 5, 7, and 11 + higher-order harmonics
X	ON	ON	OFF	5,7,11, and 13 + higher-order harmonics(#1)
X	ON	OFF	ON	Compensate 3, 5, 7, and 11 harmonics
X	ON	OFF	OFF	Compensate 5, 7, 11, and 13 harmonics
X	OFF	ON	ON	Compensate 5, 7, and 11 harmonics
X	OFF	ON	OFF	Compensate 5 and 7 harmonics
X	OFF	OFF	ON	Only compensate 5 harmonic
X	OFF	OFF	OFF	Disable harmonic compensation and only provide reactive power.
ON	X	X	X	Smart save energy mode shall be enabled.
OFF	X	X	X	Smart save energy mode shall be disabled. (#2)

(#1): Factory default configuration of harmonic selection compensation.

(#2): Factory default of smart save mode.

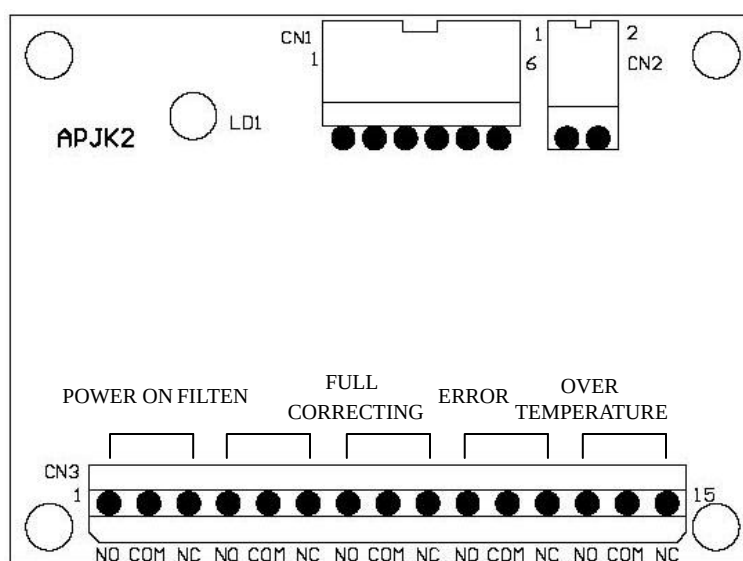
Note: Specific harmonic orders from 3 to 13 can be selected individually by users. When selecting the individual harmonic orders from 17 to 25, please contact the factory or authorized service agent.

DRY CONTACTS

The AHF has five dry contacts, 250V/2A for remote monitor.

Chart 3-4 Dry Contacts Description

Item	Dry Contact	Description
1	POWER ON	The control logic circuit of the AHF is energized.
2	FILTERING	The AHF is providing the harmonic compensating current to the load.
3	FULL CORRECTING	The load harmonic current is greater than the rated AHF compensating current. At this time, the AHF should be in current limit and continue to compensate the load harmonics up to its rated value.
4	ERROR	There are some possible external abnormal conditions or an internal malfunction. The AHF has stop providing any harmonic compensating current.
5	OVER TEMPERATURE	IGBT Module over temperature.



Drawing 3-3 The Positions of Dry Contacts on PCB APJK2

Technical support is available when you contact us any of these methods:

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